DRY PIPE SPRINKLER SYSTEM

BY

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ARMOUR INSTITUTE OF TECHNOLOGY

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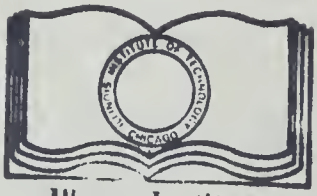

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The time factor in the
operation of dry pipe

THE TIME FACTOR

IN THE OPERATION OF

DRY PIPE SPRINKLER SYSTEM

A THESIS

PRESENTED BY

F. W. METZ W. W. MOORE
W. E. SCHULTZ

TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

FOR THE DEGREE OF

BACHELOR OF SCIENCE IN FIRE PROTECTION ENGINEERING

HAVING COMPLETED THE PRESCRIBED COURSE OF STUDY

FIRE PROTECTION ENGINEERING

1911

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P R E F A C E.

In the investigation at hand we were interested in observing the delay experienced between the fusing of a head on a dry pipe Sprinkler System and the arrival of water at the fused head. It was realized at the outset, that various conditions would affect the results, and in order to obtain data which would be of any value and also comparative between systems of different volumes, as many as possible of the factors influencing the operations were held constant thruout the tests.

The limited amount of time at our disposal made it impossible to extend the tests over a large number of installations and also confined our efforts of investigation of each system, the later being selected from general types only. For this reason auxiliary tests were made at the Underwriters Laboratories which might aid in generalizing to some extent the data obtained.

We are indebted to Professor Taylor for the method of obtaining the approximate volumes of the systems and for suggestions in the scheme of the apparatus employed in carrying out the work. To the Chicago Board of Underwriters for their cooperation, and to those concerns who have kindly permitted the use of their equipments, we take this means of acknowledging our appreciation.

DESCRIPTION OF APPARATUS.

Inasmuch as the actual fusing of a head while in position with the accompanying water discharge could not be considered, it became necessary to devise a method to replace this one and to this end was constructed the extension shown in sketch on Plate 11. This consists of a straight piece of $1\frac{1}{4}$ inch pipe, 32 inches long, capped at one end and terminating in a reducing elbow at the other, with a 1903 model Grinnell sprinkler head, modified as described under "Preliminary Tests," a quick opening valve and a brass union placed between the extremities in the order named beginning at the closed end. The reduced section of the elbow is fitted with a $\frac{1}{2}$ inch short brass nipple, the free end of which goes in the fitting ordinarily occupied by the head test. In making up the parts, care was taken to ream the ends

of the nipple and the lengths of pipe before placing them in the fittings, and to make the joints tight against air pressure.

To take care of the first water that arrives at the head, there is suspended from the extension a galvanized iron tube of 8 inch diameter, made up in 3 teles coping sections, each 3 feet in length, thus permitting adjustments for different heights. The function of the tube is to collect and direct the discharge into a basin placed on the floor beneath the head. The extension while in place is supported through the use of an adjustable standard as shown in the cut.

PRELIMINARY TESTS.

The introduction of the extension into the system added to the friction loss in the passage of air, and to correct for this, it was first necessary to find the air discharge of an open sprinkler head. For this procedure heads of different types were placed one at a time on the experimental piping of the Underwriters Laboratory, and in each case the time re-

quired for the pressure within the system to drop from 50 lbs. per sq. in. to 5 lbs. per sq.in. was noted. The results of these tests are shown under data recorded as "Air Discharge of Sprinkler Heads".

The discharge of the 1903 model Grinnell head was taken for our purpose, and it remained to bring the delivery of the extension up to this valve. This was accomplished by removing the frame from the test head, and reaming the orifice by repeated trials until the desired rate of flow was obtained. The data for this procedure is recorded under "Extension Standardization".

The next step was to observe the retarding action of the tube and modify the apparatus to overcome this, if necessary. The results shown under data recorded as "Retarding Action of Tube" led us to believe the effect of any portion to be inconsiderable, and we therefore concluded that the arrangement would yield results approximating those which would be obtained in actual practice. All data was taken with a stop watch and spring gauges so that the slight inconsistency of the data may be accounted for by the impossibility of exact accuracy. Atmospheric conditions existing on

the different days during which the tests were conducted, may account for a slight variation.

THE AIR METER.

The object of this device is to afford a means of determining the approximate volumes of the systems under test. The meter shown in sketch on Plate 1, is made of $\frac{1}{4}$ inch pipe provided with a $\frac{1}{4}$ inch union to permit of ease in erecting an elbow, a $1\frac{1}{2}$ inch.L.R.D. globe valve for throttling, a $1\frac{1}{2}$ inch x $1\frac{1}{2}$ inch x $1\frac{1}{2}$ inch tee to receive a pressure gauge, and a $1\frac{1}{2}$ inch union which contains a brass diaphragm, the latter being pierced by an orifice of 1/8 inch diameter.

Theory.

By maintaining a constant pressure on the orifice for a given interval of time, and measuring the total volume delivered during this period, the rate of discharge can be calculated for the particular nozzle pressure. If several observations, similar to the above, but with different pressures, be made, a curve showing the relation between nozzle pressure and rate of discharge can be described through the located points. To obtain the amount discharged, we employed a closed vessel of a known volume and allowed the flow to continue for a predetermined period.

Then applying Boyle's Law to the condiditions of pressure and volume before and after the run, we reason as follows:-

$$PV = P'V + Q.$$

$$\text{or } Q = V(P-P')$$

where P and P' are expressed in atmospheres.

V = Volume of vessel.

Q = Volume discharged.

It will be noted that if the difference between P and P' is one or more atmospheres, then the quantity delivered will be equal the volume of the vessel or a multiple of the volume. In calib-rating the meter, advantage was taken of this fact and the results given under this title in the data record, are those obtained while it was operating under such a drop in pressure and the calib-ration curve is plotted from the final values of the test. The divergent nature of this curve from the ordinary parabolic form of discharges against pressures may be accounted for by eddy currents occuring in the portion of the meter between the valve and the orifice.

The vessel used in arriving at our results was the nominal five hundred gallon tank of the Underwriters laboratory, the exact volume of which was predetermined. The gauge used in observing the drop in pressure was a Crosby 10 inch dial, reading to 200 lbs. per sq. in. That for indicating the pressure at the orifice was of a similar design but a 3 inch dial reading to 30 lbs. per sq. in. The final reading of the gauge after each run was taken only after a sufficient time had elapsed to insure normal temperature within the tank. Atmospheric pressure was taken as 14.5 lbs. per sq.in.

Method of Procedure.

Our first step in working on a system was to obtain its approximate volume by means of the Air meter. After the meter had been attached to the vent pipe and proper precautions taken against leakage, the throttling valve was opened and adjusted so that the pressure at the meter gauge read 15 lbs./sq. in. The time was then taken by means of a stop watch, for the pressure on the system to drop 14.5 lbs./sq.in. as recorded on the main gauge. Referring to the Air Meter calibration curve, we find that at 15 lbs. / sq.in. orifice pressure we have a rate of discharge at 144 gal. per min. which multiplied by the time would give the required volume of the system. Our results would then be checked by making another test with the orifice pressure gauge recording 5 or 10 lbs./sq.in.

After this data had been obtained, our next step was to blow off all the air in the system and erect the test apparatus at a determined position. This being done, a tap on the riser would notify the men in the valve room to set the system. A signal from below would tell the operator, all was in readiness and by means of two stop

watches and a prearranged code of signals, the men in the valve room were set in time with the operator ,(one minute being allowed after the starting of the watches. The valve at the fitting was then jerked open by the operator and the time taken by him from that instant until the arrival of water at the head. In the valve room the air pressure drop in the system was read every 5 seconds, and recorded with the time of trip. The system was then drained, at which time a signal on the riser notified the operator, who would replace the head and proceed to the next location for another test. Two tests were made on each floor, one at the nearest position to the riser, and the other at the most remote position.

EXPLANATION OF DATA SHEET.

TEST NO. Referring in order to the systems operated. The name in the upper right hand corner refers to the place of installation.

GRINNELL VALVE(OLD)- Refers to the No. 12 model of valve issued by the General Fire Extinguisher Company.

HEIGHT OF RISER- Refers to the total height in feet of

the system from the base of the riser to the upper line of sprinkler heads as discriminated from the same heading below which refers to the height of the riser in feet from the base to the head under test.

HEADS PER FLOOR. Only approximate, some systems being irregular.

NUMBER FLOORS- Covered by system.

NUMBER OF RUN- Refers in order to the tests made on the system in which the above data applies.

DISTANCE-RISER-HEAD- Number of feet from the riser to the head under test, measured along the system piping.

WATER PRESSURE. Pressure in lbs./sq.in. recorded on the gauge at the dry-valve before operation.

FINAL WATER PRESSURE. Pressure in lbs./sq.in. recorded on the gauge at the dry valve after operation.

AIR PRESSURE- Pressure in lbs./sq.in. recorded on the gauge at the dry v alve, before operation. This was always kept at 50 lbs./sq.in. for the sake of uniformity.

AIR PRESSURE AT TRIP. Pressure in lbs./sq.in. recorded on the gauge at the dry valve when the trip occurred.

TIME OF TRIP- Time in seconds from the instant the system was opened at the test fitting until the valve triped.

TIME OF WATER,- Time in seconds from the instant the systems were opened at the test fitting until water came to the head.

AIR PRESSURE-DROP- This heading refers to the data taken in the valve room from the dry valve gauge. The Time- under which will be noted 0-5-10-15- etc. in a vertical column refers to the seconds after the opening of the system. Opposite these in the horizontal columns are noted the air pressure at that instant for the various test as recorded above.

PROBABLE ACCURACY.

It is not to be supposed that with the time at our disposal and the necessary crude method of operation, our results are scientifically accurate. Our dependence upon spring gauges introduces a possibility of

error which is impossible to eliminate, and which could only be reduced to a minimum by frequent calibration and careful reading. The signal system used could very easily account for an error of a second each way in our records. On account of these many variable conditions and circumstances, it is a hard matter to ascribe any one cause to the account for the few inconsistencies that mar our results.

RESULTS.

In the actual tests of the equipment at our disposal, we succeeded in keeping the air pressure uniform at 50 lbs. per sq. in. but the water pressure necessarily varied according to the height of the source of supply. An air pressure of 50 lbs. per sq.in. was chosen as one most nearly approximating the pressure found in actual practice. A curve plotted for any single test from the data recorded as "Air Pressure Drop" would enable one to transpose the results to any single pressure below this value.

The work conducted at the Underwriters Laboratories under the head of "Variable Pressure Test" has given us sufficient data to enable an approximate transposition

and generalization of water pressure. In running these tests we close a head on the system a considerable distance from the riser to insure a reasonable time delay. The water pressure on each run was 50 lbs. per sq.in. but the water pressure was varied from 40 lbs. per sq. in. to 120 lbs. per sq.in. Owing to an inability to obtain a higher pressure the curve shows points only to that pressure, but the tendency toward a straight line is so marked, that we have felt reasonably sure of its continuity. Therefore, in order to reduce the results so as to be effective at other water pressures we have but to multiply the difference in the two water pressures by the tangent of one half the angle (16°) or .286, and add or subtract the result in seconds to or from the "Time of Water," as the water pressure is lower or higher than that in the recorded test. We do not wish, however, to lay emphasis on this unscientific analogy for results of this nature would completely ignore such factors as the volume and general characteristics of a system.

C U R V E S.

An attempt has been made to correlate the data obtained in the nature of curves plotted to show

the relation between the time interval and the height of riser. In doing this we have plotted separate curves for the results obtained nearest the riser and furthest from the riser, and followed these by describing a trip point curve in order to note any inconsistency arising in the operation of the valve.

System No.I. Durand & Kasper-Union and Lake Street, Chicago-protecting the west building and extending from the basement to the seventh floor, a height of 95 feet. We find that there is a general tendency for the trip point curve to more or less shape itself to the water curve and of course gradually diverging as the height of riser increased. One marked result is that we do not find any appreciable tendency for the time interval to increase with the height of riser.

Systems No. II and III at Durand & Kasper. These two systems protect the east building and are divided horizontally, No. II covering the three top floors including a mezzanine portion, and No. III covering the lower floors. Here again we find more or less irregularity as would be expected, but nothing that would lead us to new conclusions.

Systems I, II, III, and IV at Marshall Fields & Co., warehouse, Polk Street and the Chicago River. The building is 13 stories high and is protected in the north portion of the east building by four systems, divided horizontally, No. I covering the basement and first three floors, No. II covering the next four floors, No. III the next three floors, and No. IV, the upper three floors. It will be noted along with the other characteristics mentioned above, that the water curves on this sheet seem to show a tendency to follow each other more or less. The dip on the 110 foot height may be partly accounted for by the initial air pressure being only 48 lbs. per sq.in. We yield results and no theories in regard, to the other irregularities encountered.

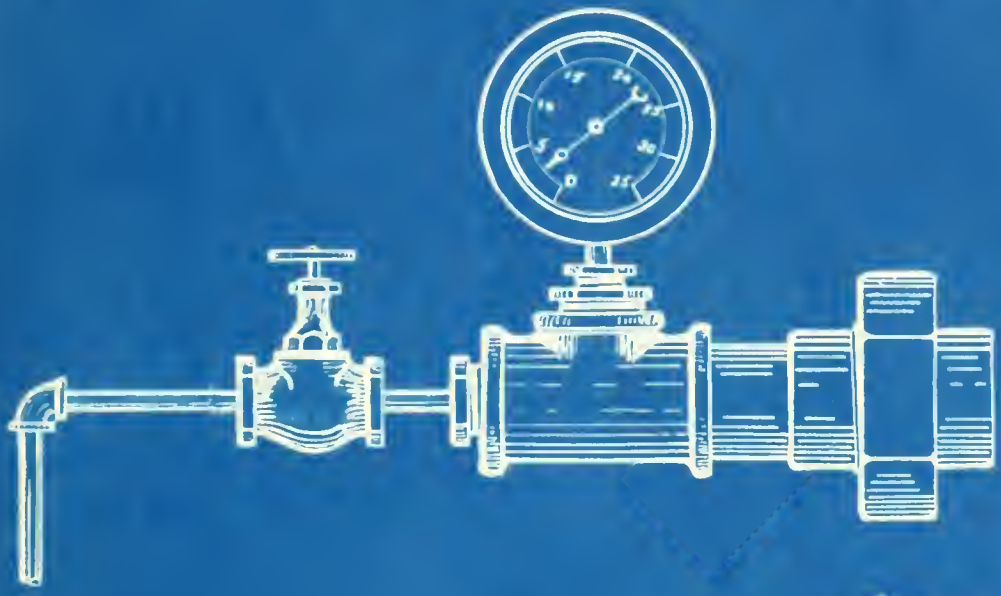
CONCLUSION.

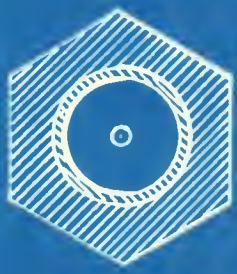
In conclusion we state that two important factors influence the operating time of a dry pipe sprinkler system, namely air discharge and water friction in pipes, all other things being equal. Of these two, the first is by far the most important, and is considerably affected by the size and length of

piping thru which it discharges. A fact worth noting is that the time delay is only very slightly effected by the height of riser. No dry pipe sprin kler system should take more than 1 minute and 30 seconds to throw water on a fire that has fused a head.

P L A T E S.

PLATE I





AIR METER
and
GAUGE FITTING

M.M.S.

PLATE II

TEST FITTING

M.M.S.

D A T A

TEST No. I. UNDERWRITERS LABORATORIES

SIDE CENTRAL FEED
DIAMETER OF RISER--4"
HEADS per FLOOR--48 (approx)
6' BRANCHES
VOLUME OF SYSTEM-----195 GALLONS
GRINNELL STRAIGHTWAY VALVE
HEIGHT OF RISER--50'
NUMBER OF FLOORS---4
8' SPACING HEADS

NUMBER OF RUN	I.	2.	3.	4.	5.	6.	7.	8.	9.
HEIGHT OF RISER-ft.	8.	8.	26	26	26	26	36	36	36
DISTANCE-RISER-HEAD'	7	75	I2	70	78	I45	I7	75	79
WATER PRESSURE(lbs)	I25	I25	I20	I26	I23	I25	I25	I26	I26
FINAL WATER PRES.	I02	I04	I02	I06	I03	I04	I02	I06	I05
AIR PRESSURE	50	50	50	50	50	50	50	50	50
AIR PRES. AT TRIP	I7	I7	I7	I7	I7	I7	I7	I7	I7
TIME OF TRIP-sec.	29	3I	27	3I	28	33	3I	36	3I
TIME OF WATER-sec.	29	33	29	34	3I	39	33	4I	37

AIR PRESSURE DROP

TIME-sec.	Pressure I.	2.	3.	4.	5.	6.	7.	8.	9.
0	50	50	50	50	50	50	50	50	50
5	42	43	42	43	43	43	44	45	43
I0	36	36	33	37	35	36	37	35	35
I5	30	3I	28	3I	28	3I	30	30	30
20	24	26	22	26	22	26	25	25	26
25	I9	2I	I8	22	I8	22	2I	2I	22
30	--	I8	--	I8	--	I9	--	I8	I8

TEST No. 2. DURAND & KATTER

CENTER CENTRAL FEED
DIAMETER OF RISER--4"
HEADS per FLOOR--5I
5' BETWEEN BRANCHES
VOLUME OF SYSTEM------270 GALLONS

GRINNELL VALVE (OLD)
HEIGHT OF RISER--95'
NUMBER OF FLOORS--7
8' BETWEEN HEADS

NUMBER	I.	2.	3.	4.	5.	6.	7.	8.	9.	IO.	II.	I2.
HEIGHT OF RISER-ft.	I2	I2	30	30	54	54	66	66	78	78	95	95
DISTANCE-RISER-HEAD'	I4	60	5	52	5	52	5	52	IO	44	8	52
WATER PRESSURE	I29	I29	I29	I29	I29	I29	I29	I29	I29	I29	I29	I29
FINAL WATER PRES.	I22	I26	I26	I23	I24	I25	I27	I27	I26	I24	I23	I23
AIR PRESSURE	50	50	50	50	50	50	50	50	50	50	50	50
AIR PRES. AT TRIP	2I	20	I9	I9	20	20	I8	I9	I8	I9	I9	I8
TIME OF TRIP-sec.	34	54	33	50	34	46	36	44	36	4I	37	42
TIME OF WATER-sec.	34	60	36	54	39	50	43	50	42	48	44	52

AIR PRESSURE DROP

TIME-sec.	I.	2.	3.	4.	5.	6.	7.	8.	9.	IO.	II.	I2.
0	50	50	50	50	50	50	50	50	50	50	50	50
5	44	47	47	49	45	48	44	46	45	46	46	44
IO	38	44	43	47	38	44	38	4I	39	42	40	38
I5	33	42	37	42	33	39	32	36	33	36	34	34
20	29	38	3I	39	27	35	27	32	27	32	28	30
25	26	35	26	35	23	30	24	27	23	27	25	26
30	20	32	22	3I	20	27	20	24	20	24	22	23
35	--	28	I9	27	--	23	I8	2I	I8	2I	I9	20
40	--	27	--	24	--	20	--	I8	--	I8	--	I8
45	--	24	--	2I	--	--	--	--	--	--	--	--
50	--	22	--	I9	--	--	--	--	--	--	--	--
55	--	20	--	--	--	--	--	--	--	--	--	--

Note:- System tied on runs #11 and #12

System clear of water vapor on run #8.

TEST No. 3. DURAND & KASTER

CENTER CENTRAL FEED
DIAMETER OF RISER--5"
NUMBER HEADS per FLOOR--80
7' BETWEEN BRANCHES
VOLUME OF SYSTEM-----300 GALLONS
GRINNELL VALVE(OLD)
HEIGHT OF RISER--95'
NUMBER OF FLOORS--4
8' BETWEEN HEADS

NUMBER OF RUN	1.	2.	3.	4.	5.	6.	7.	8.
HEIGHT OF RISER feet	95	95	87	87	78	78	66	60
DISTANCE-HEAD TO RISER ft	II	5I	9	38	6	49	I0	45
WATER PRESSURE lbs./sq.in	I32	I32	I30	I30	I29	I29	I30	I3I
FINAL WATER PRESSURE	I29	I29	I30	I29	I28	I28	I28	I30
AIR PRESSURE lbs./sq.in.	50	50	50	50	50	50	50	50
AIR PRESSURE AT TRIP	I8	I8	I8	I7.5	I8	I7	I8	I8
TIME OF TRIP sec.	4I	45	40	48	4I	44	4I	52
TIME OF WATER sec.	48	52	45	53	45	49	44	56

AIR PRESSURE DROP

TIME sec.	1.	2.	3.	4.	5.	6.	7.	8.
0	50	50	50	50	50	50	50	50
5	45	46	44	46	44	45	45	46
I0	40	46	38	42	38	40	40	42
I5	34	36	33	36	33	35	34	38
20	30	3I	30	32	30	30	30	34
25	26	29	26	29	27	28	27	30
30	23	26	23	26	23	25	23	27
35	20	23	20	23	2I	22	20	25
40	I8	20	I8	20	I8	I9	I8	22
45	--	I8	--	I8	--	--	--	20
50	--	--	--	--	--	--	--	I8

Notes:- System tied for drainage on runs #I and #8

Head taken 7' from the extremity of branch on #6 run

TEST No. 4. DURAND & KASPER

CENTER CENTRAL FEED
DIAMETER OF RISER--5"
HEADS per FLOOR--80(approx)
7' BETWEEN BRANCHES
VOLUME OF SYSTEM-----330 GALLONS

GRINNELL VALVE (OLD)
HEIGHT OF RISER--64'
NUMBER OF FLOORS--6
8' BETWEEN HEADS

	1.	2.	3.	4.	5.	6.
NUMBER OF RUN						
HEIGHT OF RISER -feet	54	54	43	42	13	12
DISTANCE-RISER TO HEAD-feet	71	58	9	47	7	74
WATER PRESSURE lbs./sq.in.	I28	I28	I28	I28	I28	I28
FINAL WATER PRESSURE lbs./sq.in.	I27	I26	I25	I25	I25	I25
AIR PRESSURE lbs./sq.in.	50	50	50	50	50	50
AIR PRESSURE AT TRIP lbs./sq.in.	17	18	18	18	17.5	18
TIME OF TRIP-seconds	42	46	38	44	39	48
TIME OF WATER-second	45	50	42	49	41	50

AIR PRESSURE DROP

TIME-seconds	1.	2.	3.	4.	5.	6.
0	50	50	50	50	50	50
5	45	46	45	45	45	46
I0	39	42	39	40	39	41
I5	34	36	33	35	33	36
20	30	32	29	31	28	33
25	27	30	26	26	25	29
30	23	27	23	26	2I	26
35	20	23	I9	23	I9	24
40	I7.5	20	--	21	--	21
45	--	I8	--	I8	--	I9

TEST No. 5. MARSHALL FIELD & COMPANY

SIDE CENTRAL FEED
DIAMETER OF RISER--6"
HEADS per FLOOR--144
9' BETWEEN BRANCHES
GRINNELL VALVE(DRY)
HEIGHT OF RISER--50'
NUMBER OF FLOORS--4
6' BETWEEN HEADS
VOLUME OF SYSTEM------530 GALLONS

NUMBER OF RUN	1.	2.	3.	4.	5.	6.	7.	8.
HEIGHT OF RISER-ft.	10	10	26	26	38	38	50	50
DISTANCE-RISER-HEADS ft.	8	106	13	81	8	108	8	108
WATER PRESSURE lbs.	166	165	164	163	163	166	166	167
FINAL WATER PRESSURE lbs.	160	150	159	159	166	171	170	172
AIR PRESSURE lbs.	50	50	49	50	50	50	50	50
AIR PRESSURE AT TRIP lbs.	34	33	23.5	23.5	23	23.5	23	24
TIME OF TRIP seconds	56	93	53	63	53	64	55	60
TIME OF WATER seconds	58	100	56	70	56	70	58	67

-- AIR PRESSURE DROP --

TIME(SEC.)	PRESSURE 1.	2.	3.	4.	5.	6.	7.	8.
0	50	50	49	50	50	50	50	50
5	47	48	45.5	47	47	47.5	47	47.5
10	44	46.5	42.5	44.5	44	46	44	45
15	40.5	45	40	42	41	44	41.5	43
20	37.5	44	37	40	38	42	38	41
25	35	42	33.5	37.5	35	39.5	35	38.5
30	32.5	40	31	35	33	37	32.5	36
35	30	38	29	32	30.5	35	30.5	33.5
40	29	36.5	27	30	28	33	29	31.5
45	27	35	25	28.5	26	31	27	29.5
50	25.5	33.5	23	26.5	24	29	25	27
55	24	32	--	24	--	27	23	26
60	--	31	--	23	--	25	--	24
65	--	30	--	--	--	--	--	--
70	--	28.5	--	--	--	--	--	--
75	--	27	--	--	--	--	--	--
80	--	26	--	--	--	--	--	--
85	--	24.5	--	--	--	--	--	--
90	--	23.5	--	--	--	--	--	--

TEST No. 6. MARSHALL FIELD & COMPANY

SIDE CENTRAL FEED
DIAMETER OF RISER--6"
HEADS per FLOOR--144
9' BETWEEN BRANCHES
GRINNELL VALVE(OLD)
HEIGHT OF RISER--98'
NUMBER OF FLOORS--4
6' BETWEEN HEADS
VOLUME OF SYSTEM----- 640 GALLONS

NUMBER OF RUN	1.	2.	3.	4.	5.	6.	7.	8.
HEIGHT OF RISER ft.	62	62	74	74	86	86	98	98
DISTANCE-RISER-HEAD ft.	--	--	1	108	10	107	10	107
WATER PRESSURE lbs.	--	--	165	167	167	167	167	167
FINAL WATER PRESSURE lbs.	--	--	163	165	165	165	164	162
AIR PRESSURE lbs.	--	--	50	50	50	50	50	50
AIR PRESSURE AT TRIP lbs.	--	--	225	23	23	23	23	24
TIME OF TRIP seconds	--	--	63	70	59	72	61	74
TIME OF WATER seconds	--	--	66	80	64	80	66	82

AIR PRESSURE DROP

TIME secs.	PRESSURE 1.	2.	3.	4.	5.	6.	7.	8.
0	--	--	50	50	50	50	50	50
5	--	--	47.5	47.5	47	48	47.5	47.5
10	--	--	45	45.5	44	46	45	45.5
15	--	--	42	43	41.5	43.5	42.5	43.5
20	--	--	39.5	41	39	41.5	39.5	42
25	--	--	37	39	36.5	39.5	37	40
30	--	--	34	36.5	34	37	34	37.5
35	--	--	32.5	34	32	35	32.5	35.5
40	--	--	30.5	32	30	33.5	30	34
45	--	--	29	30.5	28.5	31.5	28.5	32
50	--	--	27	29.5	26.5	30	27	30
55	--	--	25	28	24.5	28.5	25	29
60	--	--	23	26.5	--	26.5	23	27.5
65	--	--	--	24.5	--	25	--	26
70	--	--	--	23	--	24	--	25.4

TEST No. 7. MARSHALL FIELD & COMPANY

SIDE CENTRAL HEAD
DIAMETER OF RISER-6"
HEADS per FLOOR--144
3' BETWEEN BRANCHES
VOLUME OF SYSTEM---595 GALLONS

GRINNELL VALVE(OLD)
HEIGHT OF RISER--134'
NUMBER OF FLOORS--3
6' BETWEEN HEADS

NUMBER OF RUN	1.	2.	3.	4.	5.	6.
HEIGHT OF RISER feet	110	110	122	122	134	134
DISTANCE - RISER - HEAD feet	10	107	12	107	12	107
WATER PRESSURE lbs./sq. in.	167	168	169	168	168	168
FINAL WATER PRESSURE lbs./sq.in.	167	167	169	167	168	169
AIR PRESSURE lbs./sq.in.	50	48	50	50	50	50
AIR PRESSURE AT TRIP lbs./sq.in.	225	23	225	225	22	22
TIME OF TRIP seconds	58	60	58	72	58	65
TIME OF WATER seconds	63	71	62	83	63	76

AIR PRESSURE DROP

TIME seconds	PRESSURE 1.	2.	3.	4.	5.	6.
0	50	48	50	50	50	50
5	47	46.5	47	47.5	47	47
10	43.5	44	44	45	44	44.5
15	40.5	41.5	41.5	42	41	42.5
20	38	39	38	41	38	40.5
25	36	37	35.5	39	35.5	38
30	33	35	34.5	36.5	33	35
35	31	32.5	30.5	34	30.5	32.5
40	29	30	28	32	28	30.5
45	27	28	26	30.5	26	28.5
50	25	26.5	24	28.5	24.5	27
55	23	25	22.5	27	23	25
60	--	23	--	25.5	--	23
65	--	--	--	24	--	22
70	--	--	--	22.5	--	--

TEST No. 8. MARSHALL FIELD & COMPANY

SIDE CENTRAL FEED
DIAMETER OF RISER --6"
HEADS per FLOOR--I44
9' BETWEEN BRANCHES
VOLUME OF SYSTEM----550 GALLONS

GRINNELL VALVE (OLD)
HEIGHT OF RISER--170'
NUMBER OF FLOORS--3
6' BETWEEN HEADS

	I.	2.	3.	4.	5.	6.
NUMBER ON RUN						
HEIGHT OF RISER feet	I46	I46	I58	I58	I70	I70
DISTANCE-RISER-HEAD feet	I0	64	I6	II0	--	--
WATER PRESSURE lbs./sq.in.	I68	I68	I68	I68	--	--
FINAL WATER PRESSURE lbs./sq.in.	I65	I65	I65	I65	--	--
AIR PRESSURE lbs./sq.in.	50	50	50	50	--	--
AIR PRESSURE AT TRIP lbs./sq.in.	215	225	22	22	--	--
TIME OF TRIP seconds	70	80	66	80	--	--
TIME OF WATER seconds	75	89	72	92	--	--

AIR PRESSURE DROP

TIME seconds	PRESSURE 1.	2.	3.	4.	5.	6.
0	50	50	50	50	--	--
5	475	475	475	475	--	--
I0	445	46	45	455	--	--
I5	42	445	425	44	--	--
20	40	42	40	42	--	--
25	38	40	375	395	--	--
30	355	38	355	37	--	--
35	33	36	33	35	--	--
40	305	34	31	330	--	--
45	29	32	285	315	--	--
50	275	305	27	30	--	--
55	255	29	255	285	--	--
60	245	275	24	275	--	--
65	225	26	225	26	--	--
70	215	245	--	25	--	--
75	--	235	--	235	--	--
80	--	22	--	22	--	--

RETARDING ACTION OF TUBE.

	TIME
Time of discharge of extension without tube----------	3':03.4"
	3':00.0"
	3':02.0"
	3':01.0"
	2':56.4"
	2':56.8"
	3':03.0"
	2':59.6"
	2':57.0"
	3':05.4"
	3':02.0"
	3':00.2"
Time of discharge of extension with 2 swallows tube ---	3':00.0"
	2':59.6"
	2':54.0"
	2':57.6"
	2':56.0"
	3':01.8"
Time of discharge of extension 3 swallows of tube------	3':04.2"
	3':00.6"
	3':01.6"
	3':00.0"

VARIATION PRODUCED BY [illegible]

[illegible]

[illegible]	495	50	51	70	63	91	90	105	110	109	115
[illegible]	10	46	56	58	72F	58	81	90	92	98	98
[illegible]	50	50	50	50	50	60	50	60	50	50	50
[illegible]	3	4	06	10	115	14	145	167	155	16	165
[illegible]	42	42	45	42	30	37	35	33	33	33	32
[illegible]	56	53	46	46	42	31	40	36	37	37	34

EXTENSION STANDARDIZATION

Straight distance of a Grimsell Rope ---------- 2':57.6"

2':57.8"

Distance of modified setting ---------- 3':04.2"

" " extension(load with strain removed)---------- 3':05.6"

3':01.8"

" " " (original elasticity restored)---------- 2':56.8"

2':57.2"

Range of air pressure (30 -5) lbs./s.c.in.

CALIBRATION OF AIR METER

((Capacity of Tank))--589.8 gallons

((Barometer))----------29.75 inches of mercury

No.	TANK PRESSURE		ORIFICE PRESSURE	TIME	DISCHARGE
	INITIAL lbs./sq.in.	FINAL lbs./sq.in	lbs./sq.in.	minutes	gal/min
I.	80	5I	5	I6.62	70.6
2.	70	56	5	8.45	67.0
3.	70	26.5	I0	I6.22	I06.2
4.	65	4I.5	I0	4.75	II3.9
5.	65	50.5	I0	5.35	I09.5
6.	75	32.I	I5	I2.22	I42.0
7.	40	25.5	I5	4.05	I44.5
8.	75	32.I	20	9.57	I75.5
9.	80	66	20	5.35	I80.0

AIR DISCHARGE OF SPRINKLER HEADS

No.	TYPE.	TIME.	REMARKS.
I	Grinnell , I909	2' 58"	
2.	" "	2' 58"	
3.	Manufactures, I908. B.	3'20"	Deflector stationary
4.	" " "	3' I0"	" "
5.	" " "	3' 04"	" "
6.	" " "	3' 04"	" "
7.	" " "	3' 02"	" "
8.	Niagara, I9I0 . C.	3' 36"	
9.	" " "	2' 36"	
I0.	" " "	2' 36"	
II.	International, I908. B.	2' 35"	
I2.	" " "	2' 35"	
I3.	" " "	2' 36"	
I4.	Grinnell, (old)	3' 09"	
I5.	" "	3' 08"	
I6.	" "	3' I2"	
I7.	" "	3' I3"	
I8.	" "	3' 09"	
I9.	Manufactures, I908. B.	2' 45"	Deflector revolved
20.	" " "	2' 44"	" "
2I.	" " "	2' 44"	" "

Note:- Range of pressure 50# - 5#

CURVES.

TIME of OPERATION CURVE
SYSTEM Nº I
DURAND & KASPER

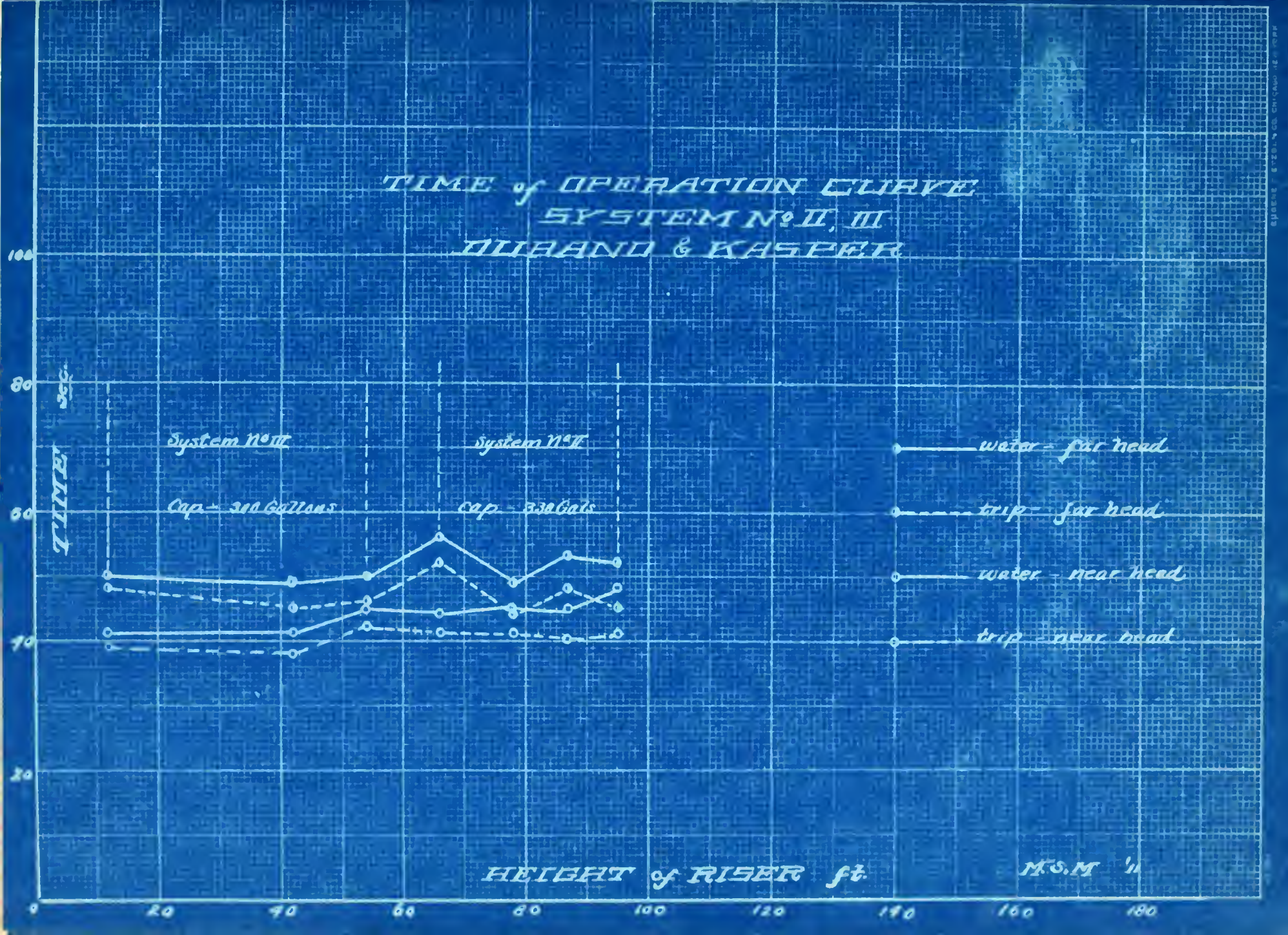
water - far head
trip - far head
water - near head
trip - near head

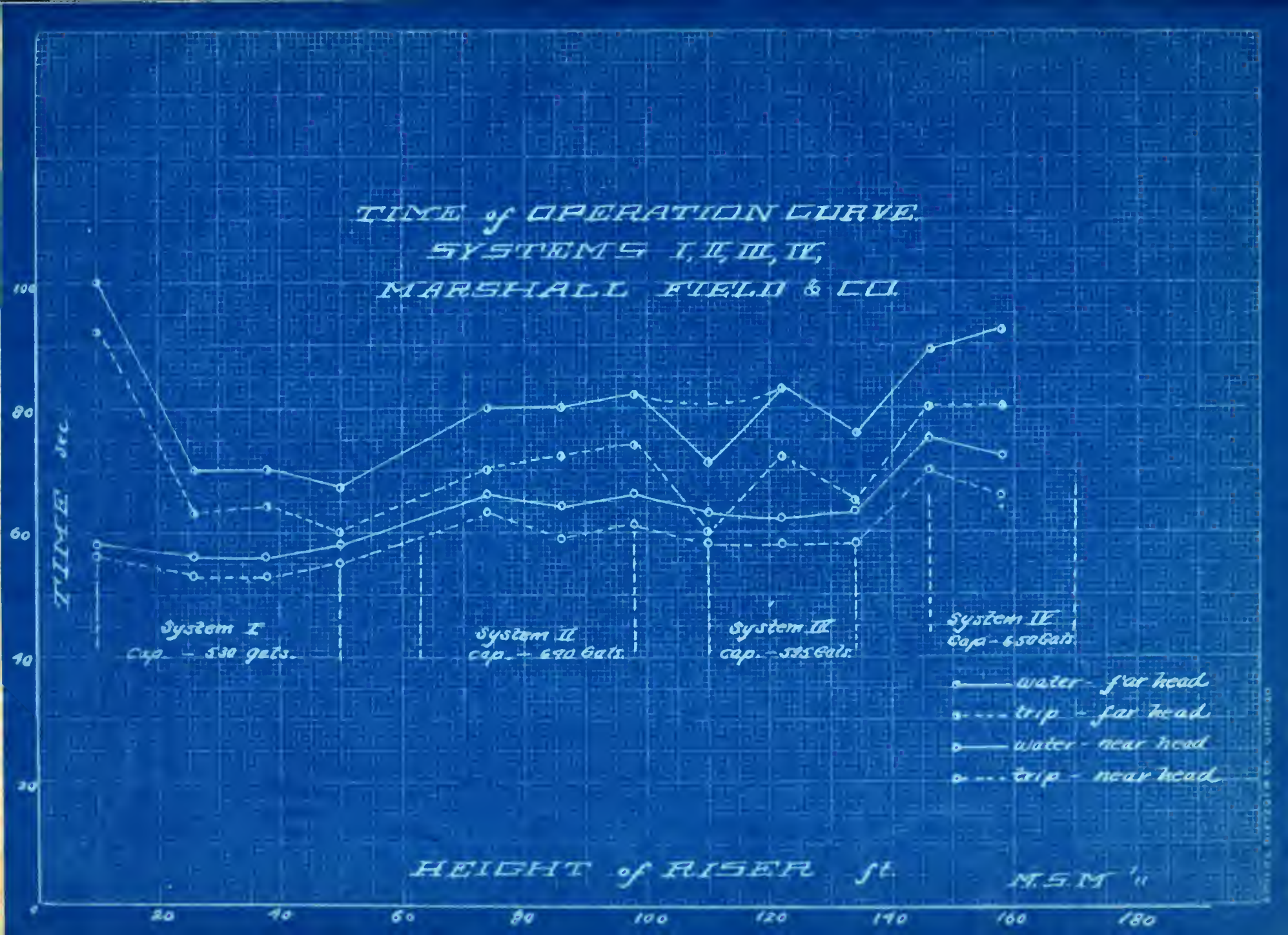
HEIGHT of RISER ft.

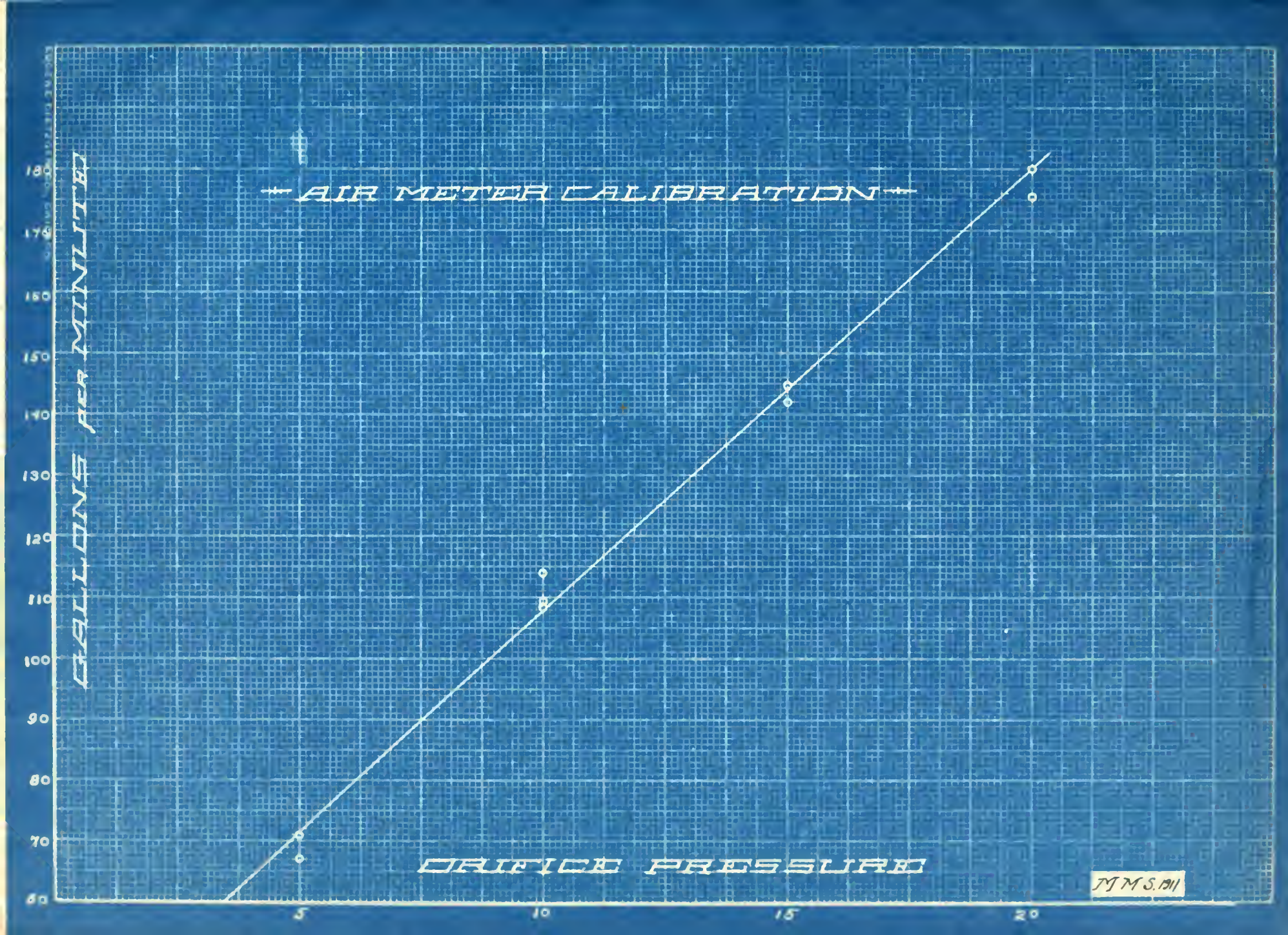
0 20 40 60 80 100 120 140 160 180

M.M.S. '11

EUGENE DIETZGEN CO., CHICAGO.


TIME of OPERATION CURVE
SYSTEM Nº II, III
DUFFAND & KASPER
TIME Sec.
100
80
60
40
20
System Nº III
Cap – 300 Gallons
System Nº II
Cap – 330 Gals
water – far head
trip – far head
water – near head
trip – near head
HEIGHT of RISER ft.
M.S.M '11
0
20
40
60
80
100
120
140
160
180


TIME of OPERATION CURVE.
SYSTEMS I, II, III, IV,
MARSHALL FIELD & CO.
TIME Sec.
100
80
60
40
20
0
System I
cap. - 530 gals.
System II
cap. - 690 Gals.
System III
cap. - 535 Gals.
System IV
cap - 650 Gals
water - far head
trip - far head
water - near head
trip - near head
HEIGHT of RISER ft.
M.S.M '11
20
40
60
80
100
120
140
160
180


AIR METER CALIBRATION
GALLONS PER MINUTE
180
170
160
150
140
130
120
110
100
90
80
70
60
ORIFICE PRESSURE
5
10
15
20
M M S. 1911